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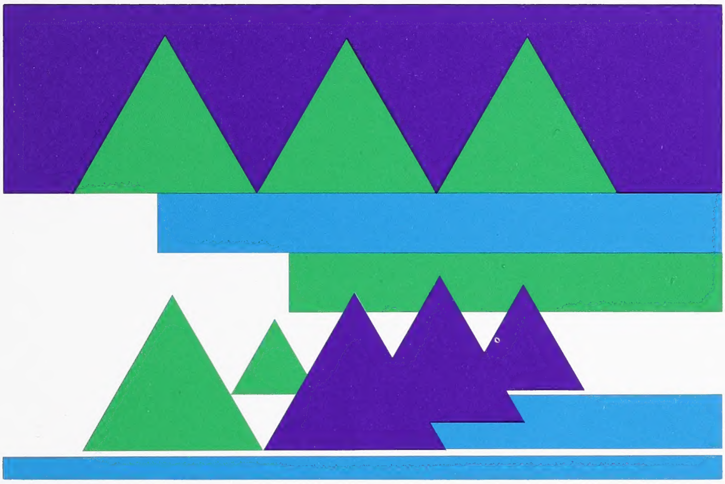
The Cold Lake-Beaver River



Water Management Study

Alberta
ENVIRONMENT
Planning Division

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Local Supply Alternative

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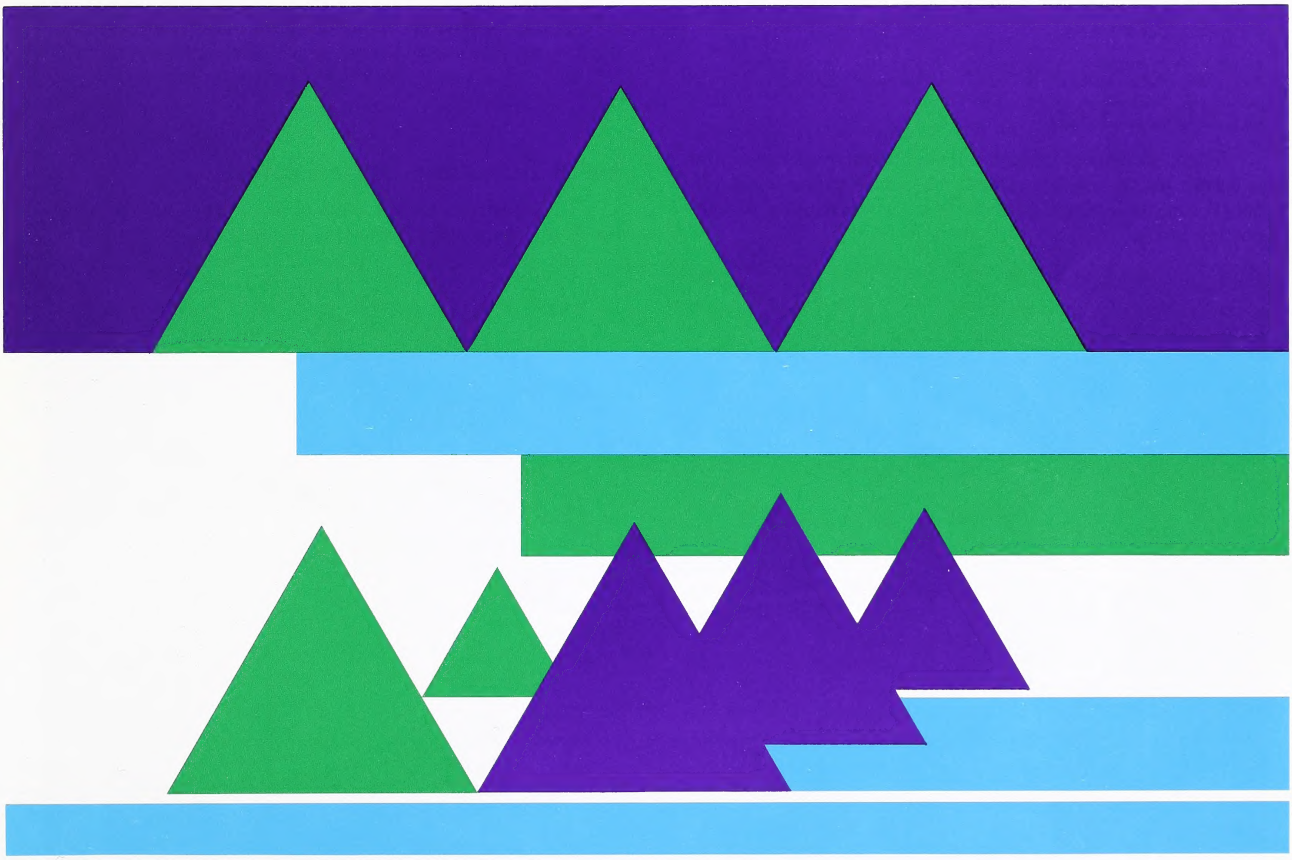
The Cold Lake–Beaver River Water Management Study



INTRODUCTION

This alternative consists of using surface water and groundwater sources within the Cold Lake and lower Beaver River basins to meet all municipal, domestic, agricultural and industrial withdrawals. Major surface withdrawals would be from Cold, Ethel, Marie, Burnt, Angling, Moose, Wolf and Caribou lakes up to limited amounts. This alternative is similar to the short-term plan except that a control structure would be built at the outlet of Cold Lake allowing withdrawals up to three and a half times what is allowed under the short-term plan. Small industrial withdrawals and water re-use requirements and water quality requirements would be met in the same manner as for the Sand River dam and North Saskatchewan River pipeline alternatives.

The withdrawal limits for the seven lakes other than Cold Lake were established during the short-term water management study and are based on criteria selected to ensure that fisheries, wildlife and recreation are not adversely affected. As a result, these lakes are not discussed in the following description.

DESCRIPTION OF COLD LAKE STRUCTURE

There are two possible locations for the outlet structure as shown in the diagram. One is very close to the outlet of the lake and the other is about 90 m downstream at the existing bridge.

The structure at the lake outlet would consist of a concrete overflow weir 40 m long with a gated section 18 m wide and rip rap protection. A structure located further downstream would replace the existing bridge. It would be a multi-box culvert with either sliding or radial gates, rip rap protection, embankment works and a fishway. Water would be withdrawn on the Alberta side of the boundary probably at or near the current Esso intake.

From an engineering standpoint this structure is quite simple compared to the other alternatives. As a result, less detailed geotechnical and design studies were required.

EVALUATION OF COLD LAKE STRUCTURE

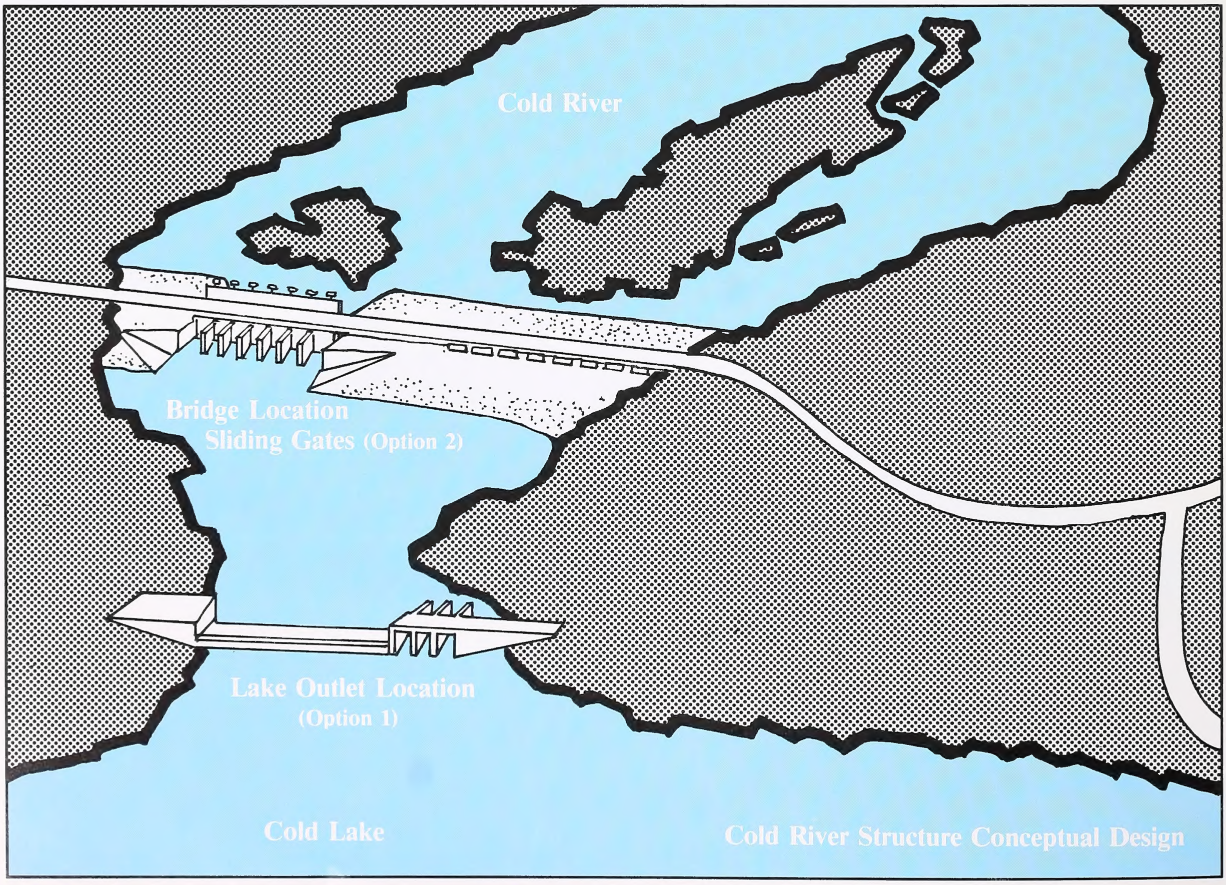
Cost

The estimated cost of constructing a structure at the outlet of Cold Lake would be $3.1 million. A structure downstream would cost about $3.8 million. Operation expenditures would be minimal. Costs of structures at the other seven lakes would total approximately $1.4 million.

In comparison to the other alternatives this cost is very low.

Local Economic Opportunities

The construction of a control structure would provide few if any temporary jobs for area residents.



Water Supply Reliability

Cold Lake would provide a reliable source of water, however when lake levels fall below acceptable limits industrial withdrawals would have to be stopped temporarily. A hydrologic analysis established that no failures would occur with the structure in place if the 27 year historic streamflows recurred. A hydrologic analysis was performed using a sequence of mathematically derived potential streamflows. This stochastic hydrology analysis established that only five failures could be expected every 1,000 years. This corresponds to an annual failure rate probability of 0.5% with a maximum duration of seven months. The likelihood of failure is therefore quite low.

Difficulty of Implementation

The Cold Lake outlet structure would be located in Saskatchewan on crown land whereas the outlet structures for the other seven lakes would be located mostly on private land. Approval from Saskatchewan for the outlet control on Cold Lake will be required. The licencing process for the other lakes should be straightforward. Since Saskatchewan's review and approval requirements are similar to those required in Alberta, approval is not expected to cause unforeseen delays. Overall, little difficulty is foreseen in implementing this alternative.

Inflexibility

If the actual demand is substantially less than the forecasted demand little capital investment will be lost in comparison to the other alternatives. If the actual demand eventually exceeds the forecasted demand, measures such as increased use of groundwater, use of some portion of Saskatchewan's apportionment of Cold Lake outflows or augmentation of supplies from outside the basin could be pursued.

Overall, this results in a very flexible alternative.

Impact on Water Quality

The alteration in the monthly discharge pattern of the Cold River will directly affect lake levels and flushing rates on Pierce Lake, Lepine Lake and Lac des Iles downstream in Saskatchewan. Because the flushing rate is an important regulator of lake fertility, or trophic state, it was necessary to predict the impacts of such flow reductions on long term conditions.

Accordingly, water budgets and nutrient budgets were estimated for these downstream lakes for both present and future conditions. Compared to most nearby lakes these three lakes are rapidly flushed, with Pierce and Lac des Iles having a water renewal time of one year and Lepine having one of approximately two weeks. Based upon the alterations in natural mean monthly flows, the annual flushing rates will decrease by approximately 13-15% for each lake. This effect would be matched by a 5-10% decrease in nutrient input, resulting in a negligible change in lake phosphorus concentration.

The depths of water passage through these lakes appear to be influenced by their temperature conditions. Cold Lake is deep and consequently is slow to heat and cool, whereas Lepine is shallow and reflects air temperature changes more closely. The result is a variable pattern of temperature and depth of flow as water moves downstream from Cold Lake to Lac des Iles.

In order to assess the impact of altered flows on these characteristics predictions were carried out based upon the historical heat records for these four lakes. The analyses suggest that no significant thermal effects will accrue from this alternative. Furthermore, the analyses indicate that the healthy supply of oxygen in the deeper waters of Pierce Lake is more related to its large depth and basin size as opposed to any direct flushing of this zone by the Cold River plume.

Overall, the impact on water quality is expected to be low.

Impact on Wildlife

Literature and file data were reviewed, summer, fall and spring surveys of wildlife and wildlife habitat were carried out, and the probable effects of the project on water-related wildlife was assessed. Bio-physical habitat around the lake shores was described and preferred wildlife habitat often associated with shallow shorelines having abundant aquatic vegetation was mapped. The three lakes support large numbers of beaver, muskrat, loons, grebes, ducks and herons, and serve as staging and feeding areas for non-resident birds.

Reduced flows and water levels associated with the project do not appear to be of sufficient magnitude to cause significant impacts to water-related wildlife or its habitat. Minor adjustments of successional vegetation may occur which would have both positive and negative implications for wildlife. As a result of somewhat lower (10 cm) average winter lake levels, a small negative impact on beaver and muskrat could occur.

The total impact on water related wildlife is expected to be low.

Impact on Fisheries

Published data, government reports and file data, and information from knowledgeable people were reviewed and a synopsis of known information prepared concerning the fisheries of the Cold River, Pierce Lake, Lepine Lake and Lac des Iles. An inventory program was carried out in these water bodies in summer and fall 1984 and in spring 1985. Fish were collected with nets, electrofishers, and by counting fence in areas potentially affected by altered flows or lake levels. Fish habitat was surveyed around lake shorelines and in the Cold River. Potential fisheries impacts and mitigative measures were assessed from a knowledge of fish populations in the study area and the probable features and operation of the proposed Cold Lake outlet structure.

The study area contains important populations of walleye, perch, pike, lake whitefish, and lake trout, as well as several species of 'rough' or 'forage' fish. Pike and perch are known to use aquatic vegetation in lake shoreline areas for spawning and rearing (spring-summer) and pike make some use of the Cold river for this as well. Lake whitefish appear to concentrate for spawning at the Lepine Lake outlet and adjacent downstream areas of the Cold River but also spawn in the Cold River between Cold and Pierce lakes, and in the narrows between Pierce and Lepine lakes. Whitefish were also observed on spawning migration moving downstream out of Lac des Iles. Lake trout apparently originate in Cold Lake but also occupy Pierce Lake. They move through the intervening Cold River and spawn to some extent in the river itself. No information on walleye spawning or movements was discovered during the literature review or obtained during the field work.

Regulation of Cold Lake would involve a low-head control structure at the lake outlet and a reduction of average annual downstream flows by 15%. Lake levels in Pierce, Lepine and Lac des Iles would be affected little in summer but on average would decline about 10 cm in fall, winter and spring. Resultant water quality changes are not expected to be significant and effects on the lakes' littoral zones are predicted to be no more than slight. The effects on spring spawning of sport fish (walleye, pike, perch) are expected to be low since spawning and rearing activities occur at a time when regulation would change flows and lake levels little. Fish passage at the structure would be maintained by a fishway.

Due to potential impacts on incubating eggs, the reservoir operation was refined to reduce the occurrence of extremely low winter flows. As a result, potential impacts to fall-spawning fish are now considered much less of a concern. Passage of most trout and whitefish at the structures would be maintained by a fishway although some young-of-the-year may be blocked. There is some potential for habitat improvement to mitigate any residual fisheries impacts.

In total, the impact on fisheries will be moderate.

Impact on Recreation

The impact of Cold Lake outflow regulation was assessed for recreation activities on Cold, Pierce and Lepine Lakes, Lac des Isles and the Cold River. The sensitivity of the various recreation activities to changes in the water regime was determined by using information collected on each recreation activity, historic water levels and streamflow shoreline sensitivity, and water quality sensitivity.

Where appropriate, preferred levels and an acceptable range of levels were established for each recreation activity. For example, elevations were obtained for all boat launches, docks and low-lying cottages. These elevations were used to establish the effective operating range of the launches and docks and the elevation at which cottages or major docking facilities might be subject to flood damage. In addition, beach areas were assessed to determine the maximum and minimum water elevations at which they could still be used and the amount of activity they could sustain at intermediate elevations. The analysis of sensitivity to changes in lake levels considered the timing and the duration of high and low levels because some of the recreation activities occur only in certain seasons.

The assessment showed that the seasonal fluctuation of lake levels and river flows as proposed with the Cold Lake outflow regulation works will have a relatively minor impact on the quality and availability of water-based recreation opportunities.

GROUNDWATER

Based on the knowledge of the groundwater resources in the area at the conclusion of the short-term water management study, the Empress and Muriel Lake (formerly called Durlingville) bedrock channel aquifers were considered the most viable sources for large industrial or municipal users due to their location and potential supply. A computer modelling simulation of the aquifers was undertaken to measure the effects of groundwater withdrawals and determine safe yields. A combined limit of 4000 dam^3/year was established for them.

Recent groundwater exploration results, more detailed definition of the regional stratigraphy and data gathering from observations wells has disclosed that significant additional amounts of groundwater can safely be withdrawn in the region. Large aquifers have been delineated outside of the bedrock channel aquifers, particularly near the southern boundary of the air weapons range.

More important, the Sinclair bedrock channel, which extends into the air weapons range from the Helina channel near Wolf Lake, was found to be a major source of groundwater supply to the Muriel Lake regional aquifer system. As a result, the regional groundwater model was updated to more accurately simulate the Muriel Lake aquifer within the Sinclair and Helina channel in the region bounded by the Beaver River on the west, Cold Lake on the east and the air weapons range to the north. The model analysis demonstrated that at least 5600 dam^3/year could be safely withdrawn from the Muriel Lake aquifer within this segment. Under the most optimistic conditions, given the current understanding of the aquifer, up to 29,000 dam^3/year could be withdrawn.

Additional amounts of groundwater would be available from the Empress aquifer and large surfical aquifers in the region. The safe withdrawal limits from the surficial aquifers would have to be determined on a site-specific basis.

A three-dimensional model analysis would be required to determine the safe long-term withdrawal limits, within the above range, for the bedrock channel aquifers.

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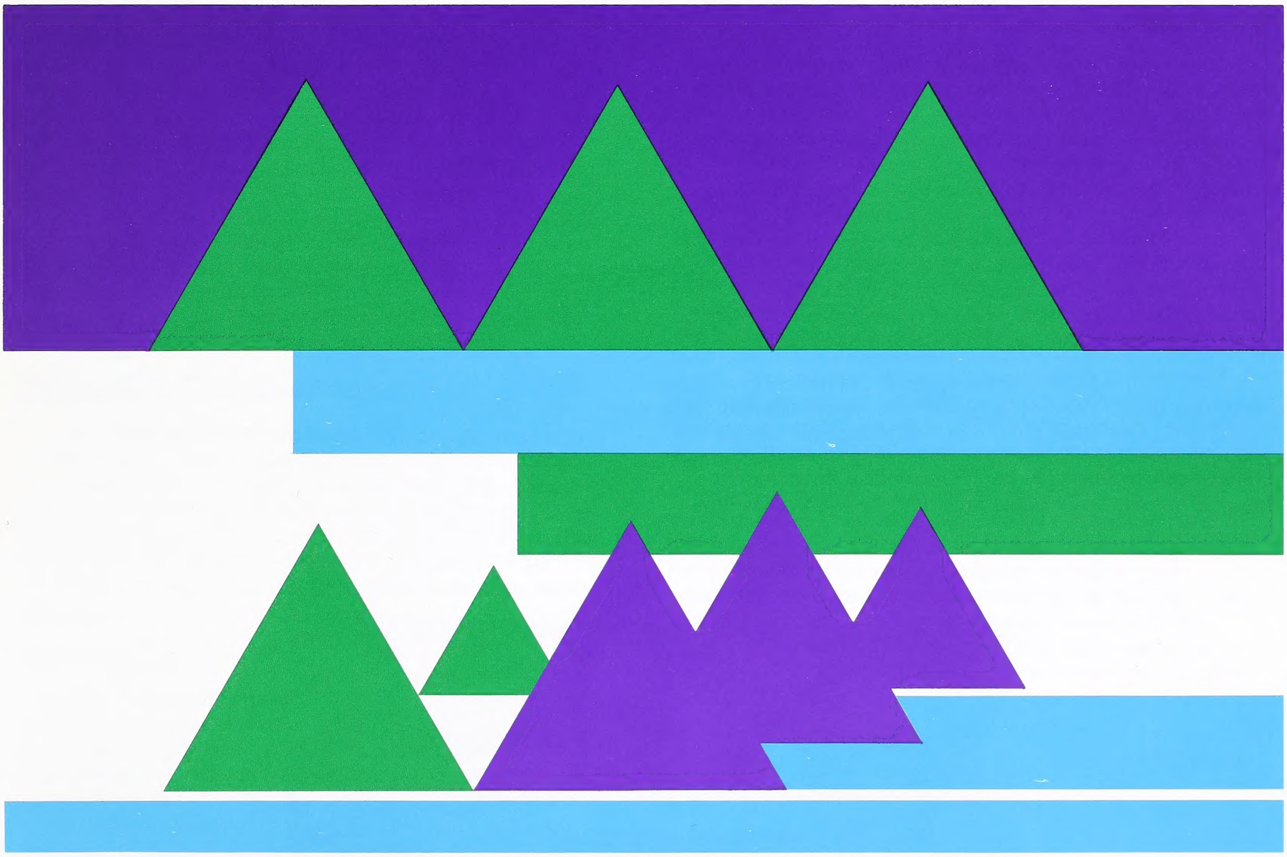
Sand River Dam
Alternative

The Cold Lake—Beaver River Water Management Study



INTRODUCTION

With the Sand River Dam alternative, all major industrial withdrawals would be met from within the Cold Lake and Beaver River basins from surface water supplied from either the Sand River reservoir or from the Sand and Beaver Rivers downstream of the reservoir. All municipal, domestic and agricultural withdrawals would be met from surface water and groundwater sources within the basins. Small industrial withdrawals, water use requirements and water quality requirements would be met in the same manner as for the local supply and pipeline alternatives.

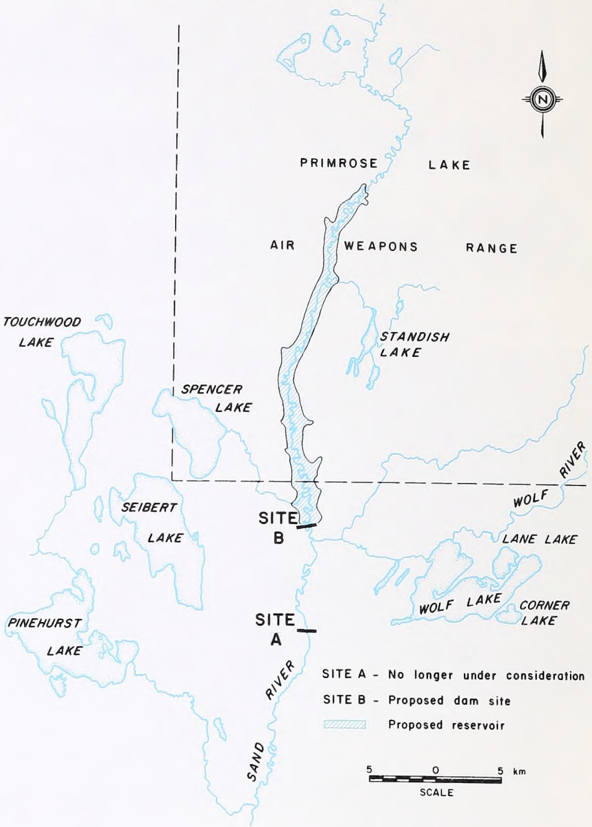
DESCRIPTION OF DAM

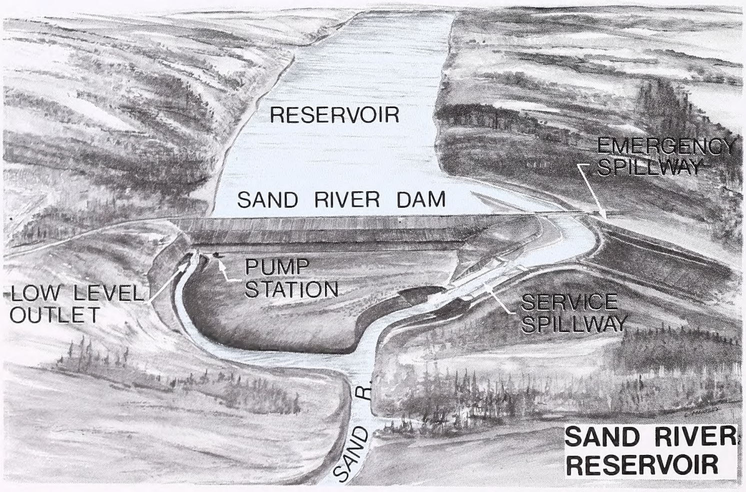
This alternative involves the construction of an earthfill dam 35 m high and 900 m across. It would be located on the Sand River just upstream of its junction with Wolf Creek (see map). The reservoir created would be 28 km long and all but 1.5 km would be in the Primrose Lake Air Weapons Range. Water for industry would be withdrawn either directly from the reservoir and/or from the Sand and Beaver Rivers downstream.

The downstream release system would combine a service spillway where water would pass over a 30 m crest and then into a long chute (see drawing) and a low level outlet where regulated flows would be released. The dam construction may last as long as five years due to time required for settling of the earth fill. An emergency spillway is included to handle severe flood conditions including flows up to 765 m^3/s. Construction roads would be required between the damsite and local gravel sources. Permanent access to the site would be via a road approaching from the B.P. Canada's Wolf Lake Plant site and passing north of Wolf Lake. This access would not be open to the public.

Geotechnical studies have shown the foundation conditions to be difficult but feasible for the construction of such a dam. An extensive drilling program (28 boreholes) was undertaken at the proposed dam site. The depth of compressible sediments in the foundations is uncommonly large (85 m) and has resulted in design provisions including special zoning of the dam and wick drains to handle differential settlements and ensure stability.

PROPOSED SITE FOR RESERVOIR ON SAND RIVER





EVALUATION OF ALTERNATIVE

Cost

The estimated total cost of this alternative, including operation and maintenance, is $50.6 million. The cost of the network pipelines from the river or reservoir to industrial users (their cost) is estimated to be $112.7 million. Compared to the other alternatives this cost is moderate.

Local Economic Opportunities

Estimates of expected employment are 490 person years of local employment and 810 person years of employment for people outside the basin. A major portion of the local employment would be earth moving and bulldozer work related to clearing the reservoir. Major concrete mixing facilities would likely have to be brought in from outside the basin. Thus local economic opportunities are high.

Water Supply Unreliability

The reservoir would be an unreliable water supply source if it was unable to provide the future water needs due to sustained low flows or drought conditions on the Sand River. A hydrologic analysis was performed on the 27-year period of historic stream flow information and it established that no failures would occur with the structure in place if a similar sequence of flow occurred. A stochastic (or synthetic) hydrologic analysis was undertaken and it established that 51 failures can be expected every 1,000 years, corresponding to an annual failure probability of 5%. Duration of the failure would be lengthy with periods of up to 16 months where 100% of the maximum forecasted future industrial withdrawals and downstream flow requirements could not be met. As a result, unreliability is rated as moderate.

Difficulty of Implementation

The difficult foundation conditions may necessitate design changes and/or cause delays in construction. Since the project is located entirely on crown land, little delay is expected in obtaining required permits. The Department of National Defence which leases the Primrose Air Weapons Range from the province will require compensation for loss of the flooded area. This can be negotiated through existing agreements.

Inflexibility

This alternative is quite inflexible because the project cannot be staged to accommodate lower or higher than anticipated withdrawals. After a go-ahead is received and final design is developed it will take a number of years to complete the project. Consequently by the time the water is available the forecast of demand will be approximately five years out of date. If the actual demand is substantially less than the forecast a significant over-capacity will exist. If the actual demand is substantially higher than the forecast the reliability of the project as a water supply source will drop considerably. In summary, as with any major storage project with a long lead time the project is highly inflexible.

Impact on Water Quality

A number of field programs and office studies were carried out in support of the assessment of the Sand River Reservoir impact on water quality. Field data has been collected along the Beaver and Sand River for a number of years. They have shown the Sand River to be relatively pristine in comparision to the Beaver River and its inflow serves to dilute water quality problems in the Beaver River.

A special study was undertaken of dissolved oxygen levels in both rivers and it was established that if the oxygen levels leaving the reservoir could be enhanced a beneficial impact would be felt down to the Saskatchewan boundary. It is expected that the reservoir created will be slightly eutrophic, thermally stratified and will have very low oxygen levels in the deeper parts of the reservoir during summer and winter. A trophic upsurge (more algae) shortly after reservoir filling can be expected.

The downstream effect of the reservoir could be slightly higher levels of un-ionized ammonia, phosphorus, mercury and decreased levels of dissolved oxygen. Most of these impacts will be reduced through the use of a variable level withdrawal whereby water can be withdrawn from any level of the reservoir.

Opportunities have also been identified to aerate the water as it is passed downstream thereby increasing oxygen levels over the natural levels in winter.

The net overall impact on water quality of the reservoir is expected to be low.

Impact on Wildlife

To determine the impact of the reservoir on wildlife populations a literature review, field surveys, and office assessments were carried out by a wildlife consultant. A variety of mammals and birds presently make use of the Sand River valley because of its habitat diversity. Of prime concern is the impact on the regional moose population. Moose are relatively abundant in the area and depend upon the valley bottom habitat as an important component of their range, particularly during winter. Moose often move into the Sand River valley during mid to late winter and may also exhibit seasonal north-south movements along the valley.

The Sand River is also important habitat for aquatic furbearers and white-tailed deer and as a result the reservoir will have negative effects on all of these species. Some use of the reservoir may be made by aquatic furbearers and waterfowl, however the severe fluctuations in reservoir levels will result in this use being very limited. Some additional negative impacts can be expected during the construction period and despite plans to limit access to the reservoir some additional access will be unavoidable and will result in additional pressure on the game populations.

In summary, the impact of the reservoir on wildlife will be very high.

Impact on Fisheries

Literature reviews, field surveys, and office assessments were carried out by a fisheries consultant regarding the impact of a Sand River Dam. In 1984 fish movements were monitored intensively in spring near the Sand - Wolf rivers confluence, and fish and fish habitat were also surveyed in summer. A total of 4965 fish were enumerated during the spring period. Of this population 6% were northern pike and 93% were suckers. During the summer period only a single sport fish (yellow perch) was found in the Sand River although a number of pike and perch were found in the Wolf River.

The Sand River appears to support primarily suckers and small 'forage' species of fish, at least under the relatively low flows which have occurred in the last few years. Major habitat limitations exist for sport fish and only a small population of pike seems to be present. During higher flow years sport fish populations may increase somewhat and include some walleye. Far downsteam in the Sand River near the highway 55 bridge successful walleye fishing has been reported. The construction of the Sand River Dam will impact on the small pike populations and any transient use of the area by walleye. Impacts will also occur on the rough fish populations. These effects will be due to migration blockage, reduced spring and summer flows and poor water quality in the spring and early summer.

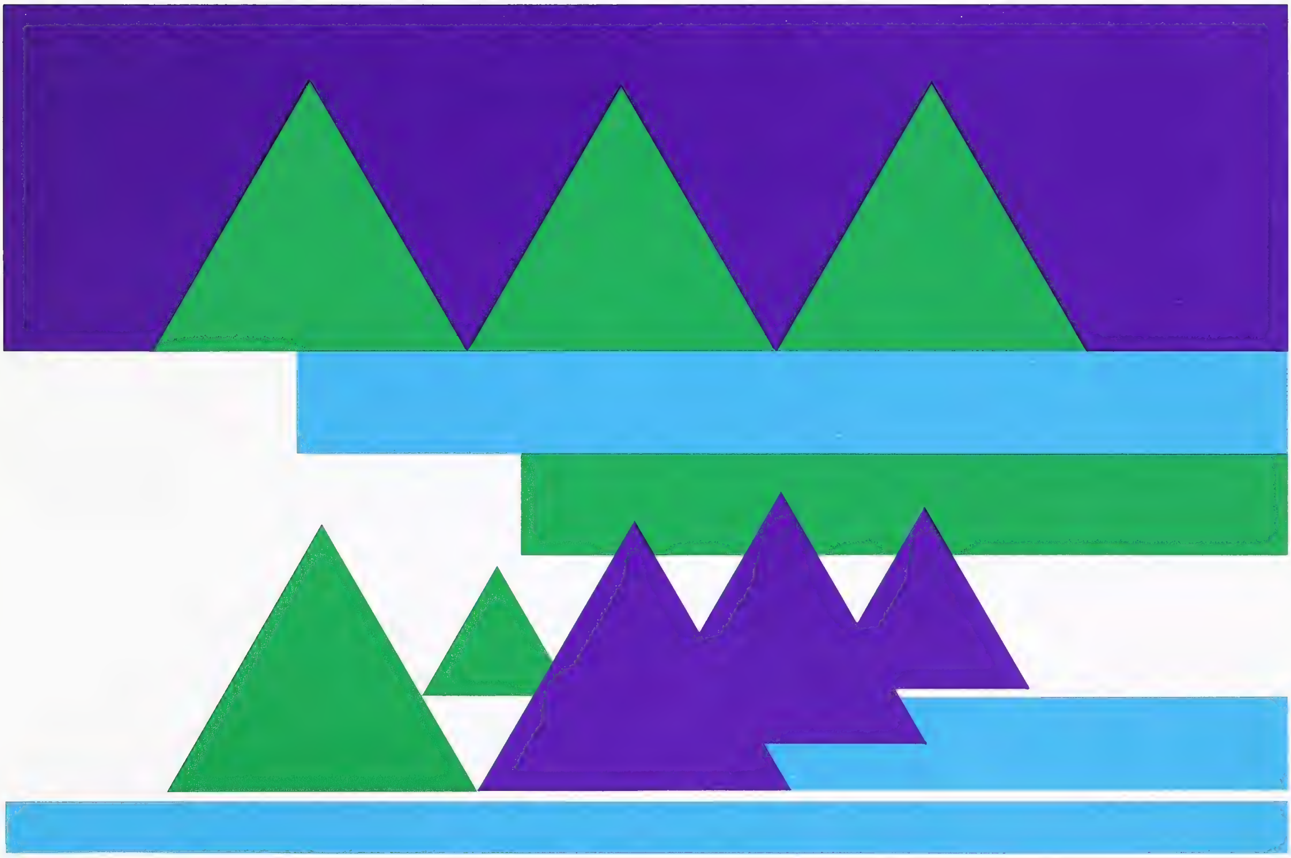
In the lower Sand and Beaver Rivers slight benefits will result from increased winter flows and any increases in dissolved oxygen levels. Mercury problems often associated with reservoir flooding may appear in pike and walleye both in the reservoir and downstream in the Sand River. The net effect will be a moderate decline in pike populations and a small decline in walleye populations.

Impact on Recreation

The damsite was chosen to avoid interference with the recreational use of the Sand and Wolf rivers and consequently the impact on recreation use will be low. There will be a small, limited impact on canoeing in the Sand River as spring floods will decrease but a more reliable baseflow will be available.

Interbasin Pipeline Alternative

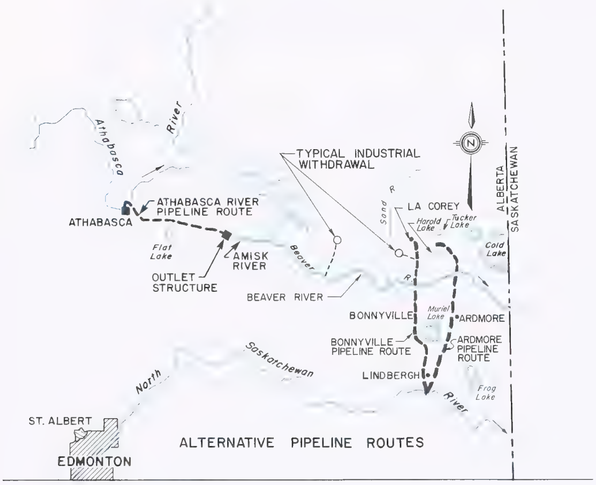
The Cold Lake–Beaver River Water Management Study



INTRODUCTION

With the pipeline alternative, all major industrial withdrawals would be met from outside the Cold Lake and Beaver River basins by surface water supplied from either the North Saskatchewan or the Athabasca rivers. All municipal, domestic and agricultural withdrawals would be met from surface water and groundwater sources within the basins. Small industrial withdrawals, water use requirements and water quality requirements would be met in the same manner as for the local supply and Sand River dam alternatives.

Three pipeline routes were evaluated - two from the North Saskatchewan River and one from the Athabasca River. The map shows the three optional routes.



ALTERNATIVE PIPELINE ROUTES

DESCRIPTION OF PIPELINES

The two North Saskatchewan routes are very similar in all aspects. The Ardmore route is 85 km. The Bonnyville route is 5 km shorter. The Ardmore route parallels the existing Husky pipeline route and travels over less environmentally sensitive lands. It also avoids the Kehewin Indian Reserve which would be crossed with the Bonnyville route. The water could be pumped directly into a small reservoir and from there to the industrial users. Industrial users who are along the route could tap directly into the mainline and pump water to their plants. For environmental reasons explained below, municipal or agricultural users would not be permitted to use the water.

The third route involves pumping water from the Athabasca River into the Amisk River just downstream from Amisk Lake. The water would then flow down an improved channel into Little Beaver Lake and from there down the Amisk and into the Beaver River. Industrial users would withdraw water from the Beaver River. The route would be approximately 58 km long.

The basic design for all three routes is the same. It would consist of low lift pumps from the river into a sedimentation pond and high lift pumps into a high pressure steel underground pipelines. A major difference would be that a storage reservoir would be required at the end of the pipelines from the North Saskatchewan whereas the Athabasca route would empty into an improved existing channel.

An option which was examined was the use of a twinned pipeline whereby a pipeline would be built and then a second added when it was justified by the demand. Although somewhat more expensive from a construction cost standpoint this approach has a lower present value because the overall operating costs are lower. As well, there is much less risk associated with this type of phased development. It therefore is the recommended approach. The size of the pipeline required to meet the maximum forecasted development would be approximately 1.5 m in diameter if a single pipeline was built or approximately 1.1 m in diameter each if a twinned pipeline was built.

Several options exist for ownership and operation of the pipeline ranging from complete government ownership to ownership by a private company or group of companies. There are advantages and disadvantages to each option. Regardless of which option is selected, each industrial user should have equal access to the pipeline. In addition, if the province maintains ownership and operation control, consideration will have to be given to recovering construction, operation and maintenance costs through a charge based upon the amount of water used.

EVALUATION OF ALTERNATIVE

Cost

The cost of this alternative, unlike the other two alternatives, has a significant operation and maintenance component. The net present value (which includes operation and maintenance) for the twinned North Saskatchewan pipeline is $146.3 million. The network of pipelines to move the water to the individual companies is estimated to be $102.7 million. The equivalent costs for the Athabasca route are $97.5 million for the main pipeline and $93.8 for the network. Relative to other alternatives these costs are very high.

Local Economic Opportunities

The expected employment opportunities generated by North Saskatchewan pipelines are low for people in the basin (970 person-years) but high for people outside the basin (2490 person-years) for a total of 3460 person-years. The total person-years generated by the Athabasca pipeline is 2070. Most of the jobs would be associated with the manufacture of the pipelines.

Water Supply Unreliability

The North Saskatchewan River pipelines are very unlikely to experience any operational breakdown that could not be remedied in a few days. The possibility of low flows on the North Saskatchewan that would affect intake of the required withdrawal demand is also very low. The Athabasca River pipeline's operation however is expected to be very unreliable due to blockages and restrictions to flow caused by ice formation in the improved natural channel portion during cold winters.

Difficulty of Implementation

The interbasin pipeline alternatives would not be difficult to implement. Normal procedures to obtain land access and licencing mechanisms would be applicable.

Access problems are quite dependant upon the route selected. The Ardmore route is expected to have the least problems since it parallels an existing pipeline. The Athabasca pipeline has some potential additional access problems since land for channel improvements must also be acquired. The Bonnyville route passes through an Indian Reserve which could cause substantial delay.

There is some potential for delay in establishing the amount and form of government and private involvement in the funding, ownership and operation of the pipeline.

Inflexibility

The capacity of the pipeline alternatives can be increased in stages to reduce the risk of building an unnecessarily large pipeline for a forecasted demand that is never reached. However, some initial minimum capacity will have to be selected. If the demand that eventually occurs is substantially less than the minimum initial capacity the lost investment will be moderately large. If the demand that occurs is significantly more than the current forecast, additional pumps and/or pipelines can be installed as there is no realistic limit on supply from either the Athabasca or North Saskatchewan rivers.

Impact on Water Quality

Because the possibility of leakages in the pipeline system are remote, no significant impacts to water quality in the Beaver River basin are anticipated as a result of the implementation of the North Saskatchewan pipeline alternative. Small temporary impacts may occur at local stream crossings during the construction phase. Overall, the impact on water quality for the North Saskatchewan River pipeline alternative would be very low.

The impact on water quality of the Athabasca pipeline, however, would be very high. The chemical characteristics of the Athabasca River at the proposed point of withdrawal near the Town of Athabasca is significantly different from Beaver River. Increases in the concentrations of several chemical parameters in the Beaver River could result from this alternative. In addition, because the open channel portion of the Amisk River would continuously be at flood level, channel instability, erosion and other instream changes would occur.

Impact on Wildlife

An initial environmental impact assessment was undertaken of the North Saskatchewan River pipeline routes which included field reconnaissance and air photo interpretation. In the process, key ungulate areas and agricultural land use were identified. Since the Ardmore route parallels an existing pipeline no new access would be required and consequently the impact is very low. The Bonnyville route opens up new areas and so would have a greater impact on ungulates.

The Athabasca route is more difficult to assess since the greatest impacts would be due to the changes in water levels in the Amisk River and in Little Beaver Lake. Some potential benefit to muskrat may occur due to the increased minimum water levels. A number of potential negative impacts have been identified. These include impacts on aquatic furbearers due to increased sedimentation caused by channelization of the river. Changes to the channel may also destroy shoreline vegetation important to waterfowl.

Impact on Fisheries

The impact of the pipeline alternatives on fisheries was assessed from previous fisheries inventories, environmental overviews of the pipeline route and a transfaunation study which examined the possibility of introducing foreign fish parasites and fish diseases from the Athabasca or North Saskatchewan rivers into the Beaver/Churchill River basin. In the latter study, detailed lists of fish, fish parasites and diseases were compiled from available and unpublished data. In addition, regional experts were contacted and interviewed.

The two North Saskatchewan pipeline routes would have very low impact on fisheries because these alternatives would be a closed system. A closed system is one where the water would go directly from the intake at the source into the industrial users' steam injection or upgrading process without passing through the natural surface water system. The transfaunation study found fish species, diseases and parasites in the North Saskatchewan River system that have not been detected to date in the Beaver River system. If the water was to be used for municipal purposes, additional studies would have to be undertaken to determine the impact of these species, diseases and parasites on the Beaver River system and what measures would be undertaken to prevent transfer.

The study concluded, however, that the risk they would be transferred was extremely remote if passed through a closed system. Minor short term impacts on fisheries could be caused by sedimentation during construction across Moosehill Creek and Beaver River.

Alternatively, the Athabasca pipeline alternative would potentially have a very high impact on fisheries. The Athabasca pipeline alternative would not be closed but would use a portion of the Amisk River and the Beaver River to convey water to industrial users in order to reduce costs. Four fish diseases, six fish species and 32 parasites found in the Athabasca system have not been found to date in the Beaver/Churchill system. The risk posed by these agents to the Beaver River basin fisheries is considered significant.

Impact on Recreation

The North Saskatchewan River pipelines would not affect water-based recreation. The Athabasca River pipeline could have a beneficial impact on canoeing due to the augmentation of streamflows but the improvements would not be significant.

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Planning Division

The Cold Lake-Beaver River

Water Management Study

WATER QUALITY

The concentrations of several water quality parameters in the Beaver River may increase as development takes place because of increases in municipal waste discharges and industrial waste discharges if one or more upgraders are built. In addition to determining the water quality impacts of each of the water management alternatives, the predicted water quality conditions at various levels of development were compared to water quality criteria proposed by the Prairie Provinces Water Board (PPWB) for the Beaver River. The comparison was undertaken to determine what, if any, water quality management measures may be required in the future.

The PPWB has recently revised the criteria, first developed in 1979, using a new methodology. This methodology is not based on using the full assimilative capacity of the river but rather allows for only a small variation from the average existing concentrations for most parameters. The criteria are subdivided into short-term and long-term conditions. Short-term criteria are proposed to place an upper concentration limit at any point in time. Long-term criteria are proposed to monitor long-term seasonal changes in the baseline water quality of the Beaver River at the interprovincial boundary. Although the proposed criteria have not yet been adopted by the PPWB they were used in the analysis.

The scenarios studied were low and high development forecasts for the year 2000 and 2015. Two industrial waste discharge conditions were considered for the high development scenarios. The first involved a surface waste discharge from five upgraders in conjunction with the municipal waste discharges - a development situation which at one time was forecast as likely for the basin.

The second condition involved a discharge from only one upgrader in conjunction with the municipal discharge -a scenario which is now considered more realistic. For subsequent discussion, these conditions will be called the extreme loading condition and realistic loading condition respectively.

A very conservative approach was used in determining potential future violations of the criteria through the river flow and background water quality conditions that were selected. The short-term criteria were applied in conjunction with the 1:10 year seven-day low flow with a background water quality parameter concentration that would only be exceeded 25% of the time. The long-term criteria were applied in conjunction with a seasonal 1:10 year low discharge with a background concentration that would be exceeded 50% of the time. In addition, all parameters were treated as if they behaved in a chemically conservative way, that is, they were not assimilated by biological processes in the river.

The findings of the analysis, recognizing the conservative approach that was taken and that current waste treatment practices were assumed to continue, can be summarized as follows:

- The PPWB criteria have been set in a somewhat arbitrary manner and occasional violations of the criteria can be expected for some parameters under existing conditions.
- Under the future extreme loading condition, very large criteria violations can be expected for chloride, sodium, sulphate and phosphorus.
- Under the future realistic loading condition, the long-term criteria is met for all but phosphorus during the open water season and for all but chloride, sodium, sulphate and phosphorus during the ice cover season. (Through overwinter storage, the criteria would be met for all but sulphate and phosphorus.)
- Under the future realistic loading condition the short-term criteria is not met for all but chloride, sodium and sulphate. (Through overwinter storage the criteria would be met for sodium.)

If a less conservative approach is used in the analysis, or if the proposed PPWB criteria are made slightly less stringent when they are finalized, some of the above noted parameters would no longer violate the criteria under certain conditions. However, in order to meet the criteria for all parameters under all conditions one or more of the following alternatives would have to be implemented:

- improve waste treatment of the industrial and municipal effluents
- deep well disposal of all effluents
- transfer effluents outside the basin

An evaluation of these alternatives was completed given the potential loadings associated with the extreme and realistic future development condition. This evaluation led to the following conclusions:

- Transfer of waste effluent outside the basin to the North Saskatchewan River may not be a viable alternative given that the North Saskatchewan River may have limited capacity to accept additional waste loading in the future and given the costs.
- Under the extreme development condition, deep well disposal is the only viable alternative to reduce surface waste discharges to permitted amounts determined by the proposed PPWB criteria.
- Under the realistic development condition, deep well disposal or enhanced treatment will permit the criteria to be met.

It should be noted that the viability of the deep well disposal alternative depends upon the capability of the formations to accept the anticipated quantities. Studies being done by the Alberta Research Council should establish permissible deep well disposal volumes.

COLD LAKE / BEAVER RIVER LONG TERM WATER MANAGEMENT —

	Cost	Local economic opportunities	Water Supply Unreliability	Difficulty of Implementation	Inflexibility	Impact on Water Quality
Ardmore Route	Present Value Costs (millions of 1984 dollars) Ardmore Pipeline: Construction $122.1 Operation and Maintenance 24.2 Total $146.3 Estimated Construction Costs (millions of 1984 dollars) Network system connecting private companies to water supply $102.7 **Very High**	**Person Years* Employment** **Direct Employment** **Regional** **Other Alberta** **Total Alberta** Initial construction phase 230 490 720 Second construction phase 200 420 620 **Spin-Off Employment** Initial construction phase 290 850 1140 Second construction phase 250 730 980 **Total Employment** Initial construction phase 520 1340 1860 Second construction phase 450 1150 1600 *number of people employed in one year **High**	• very little possibility of low flows in the North Saskatchewan that would affect intake of the required withdrawal demand. • extremely low possibility of an operational breakdown that could not be remedied in a few days. **Very Low**	• no major access and land acquisition problems for pipelines. • no special approvals required. A system would be licensed under the Water Resources Act. • possible delay or difficulty in establishing form and extent of control if industry is involved in funding, ownership and operation. **Very Low**	• construction could be staged by adding pumps or twinning pipeline so little risk of oversizing if withdrawals are lower than expected. • if demand exceeds current high forecast could withdraw more by increasing capacity (adding pumps or twin pipeline). No problem with water supply from North Saskatchewan. **Moderate**	• Very little possibility of leaks so no major effects on water quality expected. There may be some small temporary effects at local stream crossings during construction. **Low**
Athabasca Route	Athabasca Pipeline: Present Value Costs (millions of 1984 dollars) Construction $74.4 Operation and Maintenance 23.1 Total $97.5 Estimated Construction Costs (millions of 1984 dollars) Network system connecting private companies to water supply $93.8 **High**	**Person Years Employment** **Direct Employment** **Regional** **Other Alberta** **Total Alberta** Initial construction phase 0 460 460 Second construction phase 0 340 340 **Spin-Off Employment** Initial construction phase 0 730 730 Second construction phase 0 540 540 **Total Employment** Initial construction phase 0 1190 1190 Second construction phase 0 880 880 **Low**	• very little possibility of low flows on the Athabasca that would affect intake of the required withdrawal demand. • very high possibility of operational breakdown due to ice in the natural channel portions of the system during very cold winters. **Very High**	• acquiring land for channel improvement works would be more difficult than for the buried pipeline segment because the land would be lost to productive use and more landowners would be involved. • no special approvals required. System would be licensed under the Water Resources Act. • possible delay or difficulty in establishing form and extent of control if industry is involved in funding, ownership and operation. **Low**	• construction could be staged by adding pumps or twinning pipeline so little risk of oversizing if withdrawals lower than expected. • could withdraw more water than current high forecasts by increasing pipeline capacity and more channel improvements. More channel works might result in some minor flooding of farmland. No problem with water supply from Athabasca River. **Low**	• Water from the Athabasca River may sigificantly change the chemical characteristics of the Beaver River. • Continuous high flows in the Amisk and Beaver river channels would cause channel instability and major instream changes. **Very High**
Bonnyville Route	Bonnyville Pipeline: Present Value Costs (millions of 1984 dollars) Construction $117.8 Operation and Maintenance 24.0 Total $141.8 Estimated Construction Costs (millions of 1984 dollars) Network system connecting private companies to water supply $ 86.8 **Very High**	**Person Years Employment** **Direct Employment** **Regional** **Other Alberta** **Total Alberta** Initial construction phase 230 470 700 Second construction phase 200 400 600 **Spin-Off Employment** Initial construction phase 290 820 1110 Second construction phase 250 700 950 **Total Employment** Initial construction phase 520 1290 1810 Second construction phase 450 1100 1550 **High**	• very little possibility of low flows on the North Saskatchewan that would affect intake of the required withdrawal demand. • extremely low possibility of an operational breakdown that could not be remedied in a few days. **Very Low**	• possible problems getting access through Indian Reserve. • no special approvals required. Pipeline would be licensed under the Water Resources act. • possible delay or difficulty in establishing form and extent of control if industry is involved in funding, ownership and operation. **Moderate**	• construction could be staged by adding pumps or twinning pipeline so little risk of oversizing if withdrawals are lower than expected. • could withdraw more than the current high forecast by increasing pipeline capacity. No problem with water supply from North Saskatchewan. **Moderate**	• Very little possibility of leaks so no major impacts on water quality are anticipated. There may be small temporary impacts at local stream crossings during construction. **Low**
	Present Value Costs	Person Years Employment	• Hydrologic analysis of 27 years	• Difficult foundation conditions	• construction cannot be staged.	• A reservoir would be slightly

ER MANAGEMENT — EVALUATION MATRIX

Inflexibility	Impact on Water Quality	Impact on Wildlife	Impact on Fisheries	Impact on Recreation
• construction could be staged by adding pumps or twinning pipeline so little risk of oversizing if withdrawals are lower than expected. • if demand exceeds current high forecast could withdraw more by increasing capacity (adding pumps or twin pipeline). No problem with water supply from North Saskatchewan. **Moderate**	• Very little possibility of leaks so no major effects on water quality expected. There may be some small temporary effects at local stream crossings during construction. **Low**	• Changes to habitat and slight increase in access would slightly reduce number of moose. **Very Low**	• Minor effects on fisheries could result from temporary sedimentation at the Beaver River and Mooschills Creek crossings. **Very Low**	• no change in basin lake levels or stream flow. **Very Low**
• construction could be staged by adding pumps or twinning pipeline so little risk of oversizing if withdrawals lower than expected. • could withdraw more water than current high forecasts by increasing pipeline capacity and more channel improvements. More channel works might result in some minor flooding of farmland. No problem with water supply from Athabasca River. **Low**	• Water from the Athabasca River may sigificantly change the chemical characteristics of the Beaver River. • Continuous high flows in the Amisk and Beaver river channels would cause channel instability and major instream changes. **Very High**	• low impact on wildlife from the pipeline itself. • possibly some benefit to muskrat in Little Beaver Lake due to increased minimum water levels. • possibly harmful impacts on waterfowl and aquatic furbearers due to channelization, erosion and sedimentation downstream. • Net effects: slight increase in muskrats, decline in waterfowl, beaver, mink. **Moderate**	• minor impacts on fisheries from the pipeline itself • harmful effects on fisheries from probable channelization and erosion in Amisk River. • positive effects on fisheries from greater flow in Amisk and Beaver rivers. • possibility of introducing non-native fish parasites and fish diseases to Churchill Basin. Such transfers could significantly reduce number and value of sport and commercial fish throughout the basin. **Very High**	• Increased flows in the Beaver River may improve canoeing. Other recreational opportunities unchanged. **Very Low**
• construction could be staged by adding pumps or twinning pipeline so little risk of oversizing if withdrawals are lower than expected. • could withdraw more than the current high forecast by increasing pipeline capacity. No problem with water supply from North Saskatchewan. **Moderate**	• Very little possibility of leaks so no major impacts on water quality are anticipated. There may be small temporary impacts at local stream crossings during construction. **Low**	• Increased access and some changes to habitat would reduce number of moose. **Low**	• Minor effects on fisheries could result from temporary sedimentation at the Beaver River crossing. • No other effects on fisheries are apparent as proposed route doesn't cross rivers or lakes. **Very Low**	• no change in basin lake levels or stream flows. **Very Low**
• construction cannot be staged	• A reservoir would be slightly	• Good quality habitat for moose	• Sand River and Sand-Wolf rivers	• impact on canoeing in the Sand

Bonnyville Route	Bonnyville Pipeline: Present Value Costs (millions of 1984 dollars) Construction $117.8 Operation and Maintenance 24.0 Total $141.8 Estimated Construction Costs (millions of 1984 dollars) Network system connecting private companies to water supply $ 86.8 **Very High**	Person Years Employment **Direct Employment** — Regional / Other Alberta / Total Alberta Initial construction phase 230 470 700 Second construction phase 200 400 600 **Spin-Off Employment** Initial construction phase 290 820 1110 Second construction phase 250 700 950 **Total Employment** Initial construction phase 520 1290 1810 Second construction phase 450 1100 1550 **High**	• very little possibility of low flows on the North Saskatchewan that would affect intake of the required withdrawal demand. • extremely low possibility of an operational breakdown that could not be remedied in a few days. **Very Low**	• possible problems getting access through Indian Reserve • no special approvals required. Pipeline would be licensed under the Water Resources Act. • possible delay or difficulty in establishing form and extent of control if industry is involved in funding, ownership and operation. **Moderate**	• construction could be staged by adding pumps or twinning pipeline so little risk of oversizing if withdrawals are lower than expected. • could withdraw more than the current high forecast by increasing pipeline capacity. No problem with water supply from North Saskatchewan. **Moderate**	• Very little possibility of leaks so no major impacts on water quality are anticipated. There may be small temporary impacts at local stream crossings during construction. **Low**
Sand River Reservoir (Site B)	Present Value Costs (millions of 1984 dollars) Sand River Dam: Construction $47.8 Operation and Maintenance 2.8 Total $50.6 Estimated Construction Costs (millions of 1984 dollars) Network system connecting private companies to water supply $112.7 **Moderate**	Person Years Employment Regional / Other Alberta / Total Alberta **Direct Employment** 200 300 500 **Spin-Off Employment** 290 510 800 **Total Employment** 490 810 1300 **Very High**	• Hydrologic analysis of 27 years of streamflow information established that there would be no failures with a similar sequence of flow. However, stochastic analysis (a mathematically derived sequence of possible flows) established that 51 failures can be expected every 1000 years (an annual failure rate probability of 5%). Industrial withdrawals would be shut off for periods up to 16 months. • extremely low possibility of an operational breakdown that could not be remedied in a few days. **Moderate**	• Difficult foundation conditions may require design changes and cause delay during construction. • Would be located entirely on crown lands. • Department of National Defence approval and compensation for loss of land use can be negotiated through existing agreement. There is a procedure for licensing. • The question of whether to charge industrial users for works has to be decided. **Low**	• construction cannot be staged. There would be little opportunity to adjust final capacity once selected because of the length of time necessary for final design and construction. • could not meet withdrawal demands above the current high development forecast without many water supply failures or reduced downstream flows. **Very High**	• A reservoir would be slightly euthrophic (rich in nutrients) and thermally stratified and have very low oxygen levels in the deepest parts during summer and winter. Soon after the reservoir is filled there will probably be a sharp increase of nutrients. • Release of water from the reservoir would increase phosphorus and ammonia and decrease dissolved oxygen downstream. Withdrawals from different levels of the reservoir would reduce effects. **Low**
Local Supply	Present Value Costs (millions of 1984 dollars) Outlet Structure: — Lake Outlet / Outlet at Bridge Construction $4.8 $5.6 Operation and Maintenance 0.4 0.4 Total* $5.2 $6.0 Estimated Construction Costs (millions of 1984 dollars) Network system connecting private companies to water supply $89.5 to $115.2 (depending on amount of ground water used) *includes costs for outlet structures at lakes in Alberta **Very Low**	Person Years Employment Total Alberta / Total Saskatchewan **Direct Employment** Lake Outlet 35 20 Bridge Outlet 40 25 **Spin-Off Employment** Lake Outlet 50 30 Bridge Outlet 60 35 **Total Employment** Lake Outlet 85 50 Bridge Outlet 100 60 **Note:** Employment on construction of Cold Lake structure assumed to be split evenly between provinces. **Moderate**	• Hydrologic analysis of 27 years of streamflow information established that there would be no failures with a similar sequence of flow. However, stochastic analysis (a mathematically derived sequence of possible flows) established that five failures can be expected every 1000 years (an annual failure rate probability of .5%) with industrial withdrawals shut off for up to seven months. • extremely low possibility of an operational breakdown that could not be remedied in a few days. **Low**	• Cold Lake structure would be located on Saskatchewan crown lands. Some outlet structures on lakes in Alberta are on private lands. • Approval of Saskatchewan required to construct Cold Lake outlet structure. Lake outlet structures and surface and groundwater withdrawals in Alberta can be readily implemented through licensing process. • Ownership and operation of Cold Lake outlet structure to be negotiated with Saskatchewan. **High**	• could easily adjust to lower than forecasted withdrawals by using only some of the acceptable surface and groundwater sources. • could meet withdrawal requirements above the current high development forecast by augmenting supply with an interbasin pipeline. **Very Low**	• No significant impacts are anticipated in or downstream from the eight lakes which would be used, provided lake level fluctuations are kept within the allowable limits defined in the short-term plan. • Flow regulation of the Cold River would not significantly affect the level of nutrients or oxygen in downstream Saskatchewan lakes. **Low**

• construction could be staged by adding pumps or twinning pipeline so little risk of oversizing if withdrawals are lower than expected. • could withdraw more than the current high forecast by increasing pipeline capacity. No problem with water supply from North Saskatchewan. **Moderate**	• Very little possibility of leaks so no major impacts on water quality are anticipated. There may be small temporary impacts at local stream crossings during construction. **Low**	• Increased access and some changes to habitat would reduce number of moose. **Low**	• Minor effects on fisheries could result from temporary sedimentation at the Beaver River crossing. • No other effects on fisheries are apparent as proposed route doesn't cross rivers or lakes. **Very Low**	• no change in basin lake levels or stream flows. **Very Low**
• construction cannot be staged. There would be little opportunity to adjust final capacity once selected because of the length of time necessary for final design and construction. • could not meet withdrawal demands above the current high development forecast without many water supply failures or reduced downstream flows. **Very High**	• A reservoir would be slightly euthrophic (rich in nutrients) and thermally stratified and have very low oxygen levels in the deepest parts during summer and winter. Soon after the reservoir is filled there will probably be a sharp increase of nutrients. • Release of water from the reservoir would increase phosphorus and ammonia and decrease dissolved oxygen downstream. Withdrawals from different levels of the reservoir would reduce these effects. **Low**	• Good quality habitat for moose aquatic furbearers and deer would be lost. • Other negative effects on moose, deer and otter from increased human access changes to habitat in downstream valley and blockage of movement. • Very little potential for aquatic wildlife in the reservoir. • Net effects: would significantly reduce numbers of moose and aquatic furbearers in the Sand River area. Some reductions in other wildlife. **Very High**	• Sand River and Sand-Wolf rivers confluence: adverse effects on pike, coarse fish and walleye due to migration blockage, reduced spring and summer flows and worse water quality in some years. • lower Beaver River: slight impact from reduced spring and summer flows; slight benefit from stabilized winter flows. • reservoir: very little sport fish potential. • mercury in fish may increase and exceed guideline in reservoir and immediately downstream. • Net moderate reduction in pike, small reduction in walleye. **Moderate**	• impact on canoeing in the Sand and Wolf rivers. Will lower spring flood peaks and regulate base or low flow. **Low**
• could easily adjust to lower than forecasted withdrawals by using only some of the acceptable surface and groundwater sources. • could meet withdrawal requirements above the current high development forecast by augmenting supply with an interbasin pipeline. **Very Low**	• No significant impacts are anticipated in or downstream from the eight lakes which would be used, provided lake level fluctuations are kept within the allowable limits defined in the short-term plan. • Flow regulation of the Cold River would not significantly affect the level of nutrients or oxygen in downstream Saskatchewan lakes. **Low**	Cold Lake - Cold River system • little affect on water-related wildlife as changes in lake levels would be small. Other Lakes • some minor impacts on wildlife in regulated lakes, such as Wolf Lake, where the range in water levels would increase slightly. **Low**	Cold Lake - Cold River system • A small number of lake trout fry may move upstream at the Cold Lake outlet: this would be prevented by an outlet structure. • Instream flow needs for fall-spawning and egg incubation can likely be met with regulated flow. • Regulated flows and lake levels are unlikely to significantly affect fish at other times or locations. • Effects on fisheries can likely be reduced by fishways and habitat improvement. Other lakes and streams • minor impacts on fish from hydraulic changes and structures. **Moderate**	• Fluctuations of lake levels and stream flows would be kept within an acceptable range by outlet control structures and have little effect on recreation. **Low**

The Cold Lake-Beaver River

Water Management Study

HOW WATER WOULD BE MANAGED

Pipeline

It is proposed that with this alternative water would be managed as follows:

A. All municipal, domestic and agricultural withdrawals would be met from within the Cold Lake and lower Beaver River basins with major surface withdrawals limited to Moose and Cold lakes.

B. All major industrial withdrawals would be met from outside the Cold Lake and lower Beaver River basins by water supplied from the North Saskatchewan or Athabasca rivers.

C. Minor industrial withdrawals for uses such as initial oil sands pilot testing would be permitted from local surface and groundwater sources.

D. When industrial withdrawal requirements reach the minor withdrawal limit the industrial user would be required to discontinue local withdrawal and obtain water supply from the North Saskatchewan River or Athabasca River pipeline.

E. All current industrial withdrawals from local surface and groundwater sources in excess of the minor withdrawal limit would be given a specified period of time to convert the source of supply to the pipeline.

F. The pipeline would be operated as a closed system with the water used for oil sands recovery and processing operations only.

G. Alberta Environment would consider options for ownership and operation of the pipeline including ownership and operation by the private sector.

H. If Alberta Environment maintains ownership and operational control of the pipeline it may consider recovery of construction, operation and maintenance costs through a charge based on the amount of water withdrawn or licenced.

I. Recycling of produced water by industry would be required.

J. Industrial and agricultural water users would be encouraged to use local treated sewage effluent and the fish hatchery wastewater.

Sand River Reservoir

It is proposed that with this alternative water would be managed as follows:

A. All municipal, domestic and agricultural withdrawals would be met from within the Cold Lake and lower Beaver River basins with major surface withdrawals limited to Moose and Cold lakes.

B. All major industrial withdrawals would be met from within the Cold Lake and lower Beaver River basins from surface water supplied from either the Sand River reservoir or the Sand and Beaver rivers downstream of the reservoir.

C. Minor industrial withdrawals for uses such as initial oil sands pilot testing would be permitted from local surface and groundwater sources.

D. When industrial withdrawal requirements reach the minor withdrawal limit the industrial user would be required to discontinue local withdrawal and obtain water supply from the Sand River reservoir source.

E. All current industrial withdrawals from local surface and groundwater sources in excess of the minor withdrawal limit would be given a specified period of time to convert the source of supply to the reservoir or downstream rivers.

F. The reservoir would be operated to maintain minimum acceptable downstream flows for fisheries, wildlife and recreation.

G. Alberta Environment would operate and maintain the reservoir but may consider recovering construction, operation and maintenance costs through a charge based upon the amount of water withdrawn or licenced.

H. Recycling of produced water by industry would be required.

I. Industrial and agricultural water users would be encouraged to use local treated sewage effluent and the fish hatchery wastewater.

Local Supply

It is proposed that with this alternative water would be managed as follows:

A. All municipal, domestic, agricultural and industrial withdrawals up to a net consumptive use of approximately 100,000 dam^3/year would be met from within the Cold Lake and Beaver River basins.

B. Withdrawals would be comprised of combinations from the following sources:
  a) Continuous surface withdrawals with major withdrawals being limited to the Beaver River and the following lakes:

Maximum Available Net Depletion (dam^3/year)

Lake	Natural Outlet	Unattended Outlet	Controlled Outlet
Cold	20,000	-	77,300
Wolf	850	6,300	-
Moose	-	3,000	-
Burnt	250	1,000*	-
Angling	190	900	-
Caribou	4,500	6,300	-
Ethel	-	700*	-
Marie	425	1,200*	-

*Available withdrawal will be less if other withdrawals are taken from the Marie Creek system.

  b) Continuous groundwater withdrawals from the surficial aquifers, bedrock channel aquifers and bedrock aquifers determined on a site specific basis.

C. Approvals for withdrawals from lakes would give minimum lake levels at which industrial withdrawals would be reduced or suspended.

D. For those seven lakes within Alberta designated for withdrawals Alberta Environment would maintain control of the operation and maintenance of outlet control works either through direct ownership or strictly enforced licence conditions. Alberta Environment may consider recovering construction, operation and maintenance costs of the outlet structure from the industrial user(s) withdrawing water from the lake through an agreement at the time of construction or a charge based upon the amount of water withdrawn or licenced.

E. For Cold Lake, Alberta and Saskatchewan would negotiate an agreement regarding ownership and operation of the outlet structure. The agreement may include recovery of construction, operation and maintenance costs through a charge based upon the amount of water withdrawn or licenced.

F. Approvals for industrial withdrawals would be

H. If Alberta Environment maintains ownership and operational control of the pipeline it may consider recovery of construction, operation and maintenance costs through a charge based on the amount of water withdrawn or licenced.

I. Recycling of produced water by industry would be required.

J. Industrial and agricultural water users would be encouraged to use local treated sewage effluent and the fish hatchery wastewater.

K. Industrial waste effluent would be discharged to deep wells and to the Beaver River.

L. Loading criteria would be established for individual waste discharges to ensure that future industrial and municipal development in the basin would not exceed total loading limits.

M. Alberta Environment would underatke a water quantity and quality monitoring program for those ground and surface waters in the province affected by withdrawals or waste discharges.

maintain the reservoir but may consider recovering construction, operation and maintenance costs through a charge based upon the amount of water withdrawn or licenced.

H. Recycling of produced water by industry would be required.

I. Industrial and agricultural water users would be encouraged to use local treated sewage effluent and the fish hatchery wastewater.

J. Industrial waste effluents would be discharged to deep wells and to the Beaver River.

K. Loading criteria would be established for individual waste discharges to ensure that future industrial and municipal development in the basin would not exceed total loading limits.

L. Alberta Environment would undertake a water quantity and quality monitoring program for those ground and surface waters in the province affected by withdrawals, waste discharges and reservoir operation.

through an agreement at the time of construction or a charge based upon the amount of water withdrawn or licenced.

E. For Cold Lake, Alberta and Saskatchewan would negotiate an agreement regarding ownership and operation of the outlet structure. The agreement may include recovery of construction, operation and maintenance costs through a charge based upon the amount of water withdrawn or licenced.

F. Approvals for industrial withdrawals would be on a permit/conditional licence basis with a fixed duration and periodic review to allow for adjustment if other water users are being adversely affected.

G. Recycling of produced water by industry would be required.

H. Industrial and agricultural water users would be encouraged to use local treated sewage effluent and the fish hatchery wastewater.

I Industrial waste effluents would be discharged to deep wells and to the Beaver River.

J Loading criteria would be established for individual waste discharges to ensure that future industrial and municipal development in the basin would not exceed total loading limits.

K. Alberta Environment would undertake a water quantity and quality monitoring program for those ground and surface waters in the province affected by withdrawals or waste discharges.

Alberta
ENVIRONMENT
Planning Division

The Cold Lake-Beaver River

Water Management Study

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Appendix A - Cold Lake-Beaver River Basin Water Demand Forecast Update

Water Resources **July 1985**

If you have comments or questions call or write:

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